

COMPARISON BETWEEN NPP-VIIRS AEROSOL DATA PRODUCTS AND THE MODIS AQUA 'DEEP BLUE' COLLECTION 6 DATASET OVER LAND

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Introduction

The Suomi-NPP satellite was launched late in 2011, carrying several instruments designed to continue the biogeophysical data records of current and previous satellite sensors. The Visible Infrared Imaging Radiometer Suite (VIIRS) aboard Suomi-NPP is being used, among other things, to determine aerosol optical depth (AOD), and related activities since launch have been focused towards validating and understanding this new dataset through comparisons with other satellite and ground-based products. The operational VIIRS AOD product is compared over land with AOD derived from Moderate Resolution Imaging Spectrometer (MODIS) observations using the 'Deep Blue' (DB) algorithm from the forthcoming Collection 6 of MODIS data.

Data used

The analysis period extends from May 1st–October 14th, 2012. Prior to this the VIIRS aerosol data were in a state of flux due to calibration/cloud mask updates. A bug introduced in a VIIRS processing update renders aerosol data from October 15th to November 27th 2012 inclusive unusable. In all cases only AOD at 550 nm is considered. Three datasets are used:

MODIS Deep Blue (Hsu et al., 2004, 2006) Collection 6

The new MODIS Collection 6 will become available in 2013. The main changes made to the Deep Blue (DB) algorithm for Collection 6 are 1) Extended coverage to vegetated surfaces, as well as bright land; 2) Improved surface reflectance models, aerosol microphysical models, and cloud screening; and 3) Simplified quality assurance (QA) flags (integer rather than bitwise), for easier use. Validation of the current MODIS Deep Blue test data suggests an absolute uncertainty better than 0.05+20% under typical conditions for QA=2 and QA=3 retrievals (used here). A very similar algorithm is currently in use for the SeaWiFS Deep Blue aerosol products and performs well (Sayer et al., 2012).

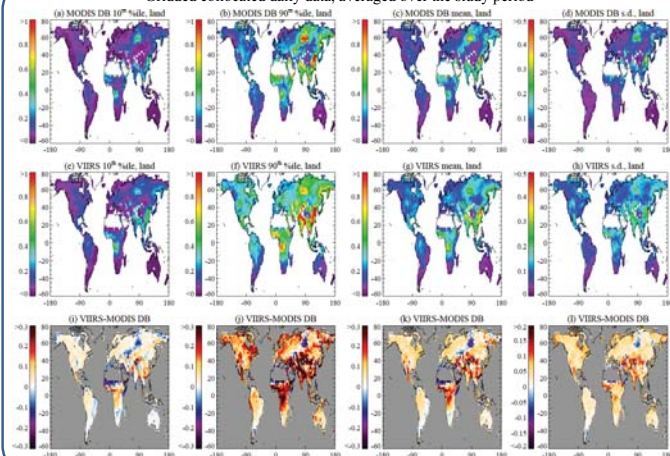
VIIRS aerosol Environmental Data Record (EDR)

This is the operational VIIRS 'level 2' product, at nominal spatial resolution of 6 km x 6 km. Only data over land with the highest quality flag (QA=3) are used. Robust total uncertainty estimates have not yet been defined. See poster A13J-0314 by Laszlo et al. for an overview and more information.

Aerosol Robotic Network (AERONET; Holben et al., 1998)

Level 1.5 (cloud screened) data are used; Level 2.0 (quality assured) data are not yet available for many sites for May 2012 onwards. Results are only shown where both MODIS and VIIRS have retrievals of sufficient quality within 30 minutes of each other and 25 km of the AERONET site, and AERONET made at least two observations during this period.

Gridded collocated daily data, averaged over the study period

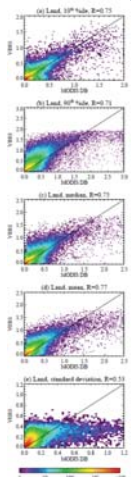


Comparison of AOD percentiles

MODIS level 3 (daily/monthly) products are often used to examine regional/global AOD. It is relevant to ask how such maps would look if constructed from VIIRS data. As well as mean AOD, percentiles of the AOD probability distribution function (PDF) are examined, to provide additional insight into differences. Note that no level 3 equivalent products are available from VIIRS, so they must be created manually.

Such a comparison is presented to the left. Daily level 2 Deep Blue and VIIRS data are gridded to 2.5° resolution and statistics of the AOD PDF saved. Only retrievals over land are used. Days in which both Deep Blue and VIIRS contained 20 or more retrievals in a given grid cell are collated, to examine the mean of these statistics from such collocated data. MODIS DB data are shown in the top row, VIIRS in the second row, and the difference in the third row. Scatter plots of the daily data are shown to the right. In summary:

- VIIRS AOD is higher than MODIS DB over most land regions, for all percentiles of the AOD distribution (the median is not shown, but looks similar to the mean).
- Time series analyses (not shown) suggest these biases persist across different months.
- Validation indicates that Deep Blue is largely unbiased in low-AOD conditions.
- These results, in tandem with other studies, suggest that assumptions about surface reflectance, and cloud contamination, are jointly responsible.
- VIIRS AOD is lower than MODIS DB in a few areas, largely corresponding to mixed dust/smoke, and smoke from fires in Russia during the summer of 2012. Conversely, in some cases of small absorbing aerosols (e.g. Asian pollution, central African biomass burning), VIIRS is higher.
- These differences may be related to aerosol microphysical model assumptions, and it is hard to say which dataset is closer to the truth.
- VIIRS AOD has a hard upper limit of 2. Both MODIS and AERONET data suggest this threshold can be exceeded in intense aerosol events.

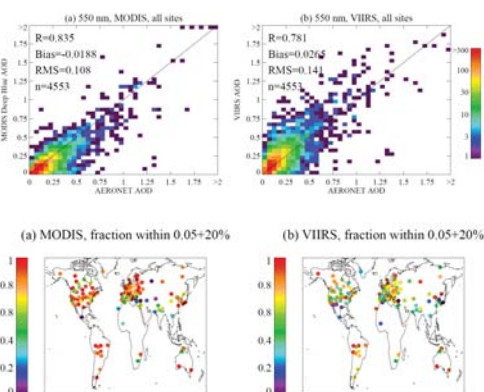


Joint AERONET validation

Scatter density histograms of AERONET against MODIS Deep Blue/VIIRS are shown to the right, using the three-way matchup protocol described in the 'data' box above.

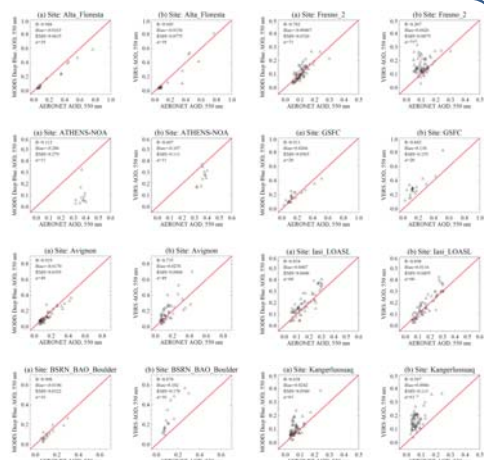
Also shown is the fraction of matchups at each site where the AERONET-satellite absolute AOD difference is within 0.05+20% of the AERONET AOD, this being a typical satellite AOD retrieval uncertainty. Only sites with 5 or more matchups are mapped.

- Only data over land are used.
- MODIS Deep Blue performs better overall, but tends to have a low bias in high-AOD conditions.
- In contrast, the VIIRS data more frequently have a high bias. VIIRS data are in beta, and the performance of VIIRS is expected to improve in the future, as the algorithm matures.



Some comparisons for specific AERONET sites are shown to the right. Note the limited sample size at many sites, the fact that the three-way comparison means that data are effectively triply cloud-screened, and the fact that these are Level 1.5 AERONET data (level 2.0 are not yet available for the study period for most sites) means that the results should be interpreted with caution.

In general, both datasets are able to track changes in AOD at a given site. At some sites (Alta Floresta, Brazil; LOASL, France) both perform well. Overall, Deep Blue tends to perform better. The VIIRS product has a high bias in conditions of low aerosol loading at many sites (Avignon, France; Boulder, USA; Fresno, USA; GSFC, USA). At a few sites (Athens, Greece; Kangerlussuaq, Greenland), both have issues. Athens is an urban site in heterogeneous and near-coastal terrain. Kangerlussuaq is in heterogeneous terrain near an ice field. These conditions pose challenges for these types of algorithm.



References

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